ENERGY ENGINEERING ANALYSIS PROGRAM

FINAL SUBMITTAL

VOLUME I

ENERGY SURVEYS OF U.S. ARMY RESERVE CENTERS AT FORT SAM HOUSTON, SAN ANTONIO, AUSTIN, AND HOUSTON, TEXAS

PREPARED FOR:

FIFTH U.S. ARMY, 90TH ARCOM, 75TH MAC,
420TH EN BDE, AND 897TH MD BDE

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EXECUTIVE SUMMARY

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I. Introduction

This report summarizes the results of an Energy Engineering Analysis Program (EEAP) performed on seven U.S. Army Reserve Centers located in San Antonio, Houston, and Austin, Texas. There are four centers in San Antonio, two of which are on Ft. Sam Houston, two in Houston, and a single facility in Austin.

The purpose of this study is to analyze all aspects of each Reserve Center's energy usage, in order to recommend practical and feasible methods of reducing the facility's total energy consumption.

II. Overview

The task of reducing the Reserve Center's energy consumption was not expected to be an easy one, due mainly to the governments recent increased awareness of energy conservation and subsequent actions to limit energy usage, such as installation of timeclocks and Energy Monitoring and Control Systems (EMCS). The scope of work for this study called for the following:

1. Computer energy simulations of all buildings included in the study which are larger than 8000 square feet.

2. Evaluation of all practical Energy Conservation Opportunities (ECO's) for each building, to include calculation of the amount of energy savings and the resulting economic feasibility,

3. Evaluation of the economic feasibility of installing EMCS systems at each Reserve Center.

4. Preparation of programming and/or implementation documentation for projects developed as a result of the study.

5. A comprehensive report to document the work performed, the results, and the recommendations.

This report is divided in separate sections (including Appendices) as shown in the Index. Sections 1, 4, and 5 are general in nature and self-explanatory. Sections 2 and 3 and Appendices contain specific calculations and analyses on each building. To avoid confusion, Sections 2 and 3 and Appendices are organized into the following order within each section:

TABLE 1 - BUILDING LIST

BUILDING	LOCATION	SQUARE FEET
1. 1520	FT. SAM HOUSTON	66039
2. 1521	FT. SAM HOUSTON	14421
3. 1610	FT. SAM HOUSTON	22019
4. 1611	FT. SAM HOUSTON	3536
5. CALLAGHAN ROAD	SAN ANTONIO	23512
6. CALLAGHAN ROAD MAINT	SAN ANTONIO	3536
7. BOSWELL STREET	SAN ANTONIO	22963
8. OLD SPANISH TRAIL	HOUSTON	100000
9. OST ANNEX B	HOUSTON	6500
10. OST ANNEX C	HOUSTON	6500
11. PERIMETER PARK	HOUSTON	34000
12. PERIMETER PARK	HOUSTON	13440
13. FAIRVIEW DRIVE	AUSTIN	29400
14. FAIRVIEW DRIVE AMSA	AUSTIN	15733

A summary of the Energy Conservation Opportunities studied is as follows:

1. Insulation of the domestic hot water storage tanks or water heaters to reduce storage losses and conserve gas energy.
2. Delamp the lighting fixtures by removing two lamps and one ballastfrom a four lamp fluorescent light fixture to reduce the lighting level and conserve electrical energy.
3. Delamp and remove one ballast from the lighting fixtures as in #2 above and install reflectors which will maintain lighting at reasonable levels and still conserve electrical energy.
4. Replace existing incandescent exit signs with higher efficiency electroluminescent exit signs to save electrical energy.
5. Install shower flow restrictors in the showers to reduce the flow of hot water and save gas energy.
6. Install photocells where not already existing on outdoor lighting, for automatic shutoff when unneeded to conserve electrical energy.
7. Installation of timeclock for the chilled water and hot water pumps so they can be programmed to run only when required, instead of constantly, to conserve electrical energy.
8. Replace existing motors with high efficiency motors when existing motors need to be replaced, which will conserve electrical energy.
9. Installation of occupancy sensors in areas that are only used sporadically such as restrooms and breakrooms to shut off lights automatically and conserve electrical energy.

10. Installation of night setback programmable thermostats in place of existing thermostats so that the temperature in the building can be lowered and/or raised at night to conserve electrical and gas energy.

11. Replace the existing older boilers with new higher efficiency boilers to conserve gas energy.

12. Lower the temperature of the domestic hot water heater to conserve energy.

13. Installation of weatherstripping on exterior doors to conserve electricity and natural gas energy.

14. Shutdown energy to existing oversized water heater and install a smaller tank in parallel, to be used during normal operation to conserve energy in the form of natural gas.

15. Install a variable speed drive on a chilled water pump to reduce pumping energy and conserve electricity.

16. Replace existing incandescent fixtures with higher efficiency fluorescent fixtures to save electrical energy.

17. Install gas-fired infrared heaters to replace older existing gas-fired unit heaters with electrical fans to save electricity and natural gas energy.

18. Install an evaporative pre-cooler at the inlet to the condenser coil of the chiller to lower the temperature of the entering air, thereby increasing the chiller efficiency and reducing electrical energy consumption.

19. Insulate the hot water heating coil headers to prevent heat loss and increase natural gas savings.

20. Disable the air conditioning system in areas where air conditioning is not required, to save electrical energy.

21. Replace old deteriorating chilled water piping insulation with new, to save electrical energy.

22. Add vestibule in existing entryway to decrease load on the heating and cooling equipment and save electrical energy.

23. Replace existing air cooled chiller with a more efficient water cooled chiller to save electrical energy.

24. Install outside air economizers on existing air handling systems, to save electrical energy.

25. Application of solar film to existing windows to lower glass shading coefficient and "U" value; therefore decreasing the heating and cooling load and providing natural gas and electrical energy savings.

26. Replace existing single pane windows with double pane windows to decrease heating and cooling load and provide natural gas and electrical energy savings.

27. Replace existing high wattage lamps and ballasts with low wattage lamps and ballasts to save electrical energy.

28. Replacement of existing electric heat rooftop units with gas-fired rooftop heating and cooling units which will reduce electrical energy requirements.

III. BUILDING DATA

Site Investigation of all seven facilities was accomplished on various dates beginning October 27, 1988, and continuing through August 5, 1989. The facilities were surveyed in the same order in which they appear in this report, beginning at Building 1520 and ending at Fairview Drive.

Building 1520 and it's companion maintenance building, 1521, were built around 1980. Both facilities are, therefore, fairly new and generally possess updated equipment. The training building (Building 1520) is a two-story facility with a light colored brick exterior and double pane tinted windows. The building covers approximately 66,000 SF of floor area. The facility is well insulated and generally in good condition. The training building's heating/ cooling system consists of individual room fan coil units mounted above the ceiling. The fan coils are two-pipe configuration which utilizes either chilled or heating water depending upon the season. Chilled water is provided by two air-cooled chillers and the heating water is supplied by a natural gas fired boiler. There is a single pump which serves double duty, pumping chilled water in the cooling season and heating water in the heating season. Switch-over from cooling to heating and vice-versa is done manually.

The maintenance building (Building 1521) is a 14,000 square foot single-story facility with a 5-bay shop area where repair and maintenance of Army Reserve vehicles is accomplished. The building has a CMU shell. The administration portion of the building which is air conditioned, is served by a single residential type upflow gas-fired furnace with a direct expansion (DX) coil. The maintenance bays are heated by ten gas fired infrared heaters. All remaining portions of the building are heated only by gas fired unit heaters. Most of the facility's lighting is at minimum levels in the office and storage areas but is at a higher level in the maintenance bays where proper illumination is more essential.

The other buildings that were surveyed on Fort Sam Houston are Buildings 1610, and 1611. These two buildings consisted of a two story training facility (Building 1610) with an accompanying maintenance building (Building 1611). Building 1610 contains approximately 23,000 square feet of floor space. The building's exterior is tan colored brick and has clear, single pane windows. Building 1610 was built around 1960. The building's mechanical system consists of a two-pipe fan coil system similar to that in Building 1520. The building's air cooled chiller is relatively new but the boiler appears to be old and run down. The most noticeable mechanical feature of the building is the domestic hot water generation system which consists of a large steam boiler generating low pressure steam which passes through a steam-to-water heat exchanger which heats the domestic hot water. In summary, the building utilizes a large steam boiler to generate domestic hot water but utilizes a separate hot water boiler to generate building heating water, which is an inefficient application of equipment.

Building 1611 which is more commonly known as the Motor Pool, has exterior walls which are constructed of eight inch CMU with four inch face brick. The building has 3536 square feet of floor area. and is not air conditioned. Each of the three maintenance bays are heated with a 40,000 Btuh unit heater.

The Reserve Center located at 600 Callaghan Road is similar to Building 1610 in appearance. The building is approximately 27 years old and contains about 24,000 square feet of floor area. The exterior of the building has the standard light colored brick and double pane windows which have apparently been retrofit into the facility sometime within the last 5 to 8 years. The heating/cooling systems within the building consist of a reciprocating chiller, with a pair of air cooled condensers, a gas fired boiler, associated pumps, one multizone air handler, one small single zone air handler, two heating/ventilating units, and several hot water unit heaters. Any spaces not served by the above equipment are served by hot water radiant heaters. Upon investigation, it was noticed that the chiller was inoperable and, according to building personnel, was to be replaced within the next few months. The boiler was not operating at the time of the field survey since it was approximately 90oF outside, but it is doubtful whether or not this piece of equipment can operate efficiently or safely, since it is composed of a casing from a standard boiler and a tube section belonging to a steam boiler of unknown origin. The "steam" section does not fit into the casing properly and when operating a severe heat loss is inevitable.

Similar to Building 1610, the Callaghan Road Reserve Center has a maintenance building which goes along with it. In fact, the building (Callaghan Road Maintenance) is practically identical in structure, area, and contents to Building 1611. The same computer simulation data was used for both buildings since they are so much alike.

The facility located at 432 Boswell Street consists of 23,000 square foot training building and a 14,000 square foot maintenance building. The training building is very similar to the building located at Callaghan Road. Appearance is the same, mechanical heating and cooling systems are basically the same, but are in better condition.

The facility located on Old Spanish Trail in Houston is the largest and newest building included in the study. It contains almost 73,000 square feet of floor area on its two floors and is approximately 7 years old. The building's skin is tan brick with double pane tinted windows. The building is in excellent condition. Air systems in the building are, for the most part, multizone air handlers. There are 4 small single zone units but the majority of the building is served by the multizone units. Refrigeration is provided by 3 packaged air cooled chillers, each with it's own chilled water pump. The building's heat is provided by hot water which is supplied from a gas-fired hot water boiler and companion hot water pump. There are 2 other buildings on the site, referred to as Annex "B" and Annex "C". Annex "B" is a 6,500 square foot storage building. The building contains a gas-fired hot water boiler and pump which is used to distribute hot water to heat the building. An air cooled condensing unit furnishes DX cooling to the building. Annex "C" has recently been completely renovated and is now referred to as the Battle Projection Center.

The facilities at 7077 Perimeter Park in Houston consist of a 16,000 square foot single story office/training building and a 13,400 square foot warehouse. Both the training facility and the warehouse are constructed of pre-cast aggregate concrete walls and lightweight insulated roofs. The windows in the training building are single-pane and tinted. The training facility is heated and cooled by 8 small packaged rooftop units. These units provide DX cooling and electric resistance heating. The units themselves appear to be in very poor condition. They leak air and it appears that the filters have not been changed for at least 2 years. The units, however, seem to maintain an acceptable level of comfort in the building. The warehouse does not have cooling capabilities but has gas-fired unit heaters to maintain space comfort in winter.

The final facility which was surveyed was the Reserve Center located at 4601 Fairview Drive in Austin. This facility is a red-brick 29,400 square foot facility with clear, single-pane windows.

The site also contains a maintenance facility of approximately 15,700 square feet. The facility is the oldest Reserve Center included in this study, as the original structure dates back to around 1953. The entire facility was renovated in 1973. This facility differs from the normal Army Reserve Center because it is directly adjcent to a newer Marines Reserve Center. For this study, only the Army Reserves portion of the building was surveyed. Mechanically, the building is similar to the majority of the other Army Reserve Centers. It has a two-pipe fan coil system with gas-fired unit heaters in the spaces which are not mechanically cooled. The packaged air-cooled chiller was recently replaced in the spring of 1989. The boiler is in very good shape, and appears to be less than 5 years old. This building, similar to some of the other Reserve Centers, was equipped with an over abundance of domestic hot water storage. The building also has recently had a timeclock/control system installed to deenergize the heating/cooling systems automatically. Fairview's maintenance facility contains typical mechanical systems; gas-fired unit heaters for heating and window units for both cooling and heating.

The building surveys of the seven U.S. Army Reserve Centers was revealing. It is very apparent that the vast majority of the buildings' occupants operate their building with an energy conservation frame of mind. The majority of the Reserve Centers possessed more energy saving retrofit implementations than was originally anticipated. Five of the seven Reserve Centers featured timeclock controls on their heating/cooling systems to some degree.

Most of the facilities had timeclock and/or photocell control for their outdoor lighting. All unnecessary lighting is deenergized by occupants almost religiously. While the facilities vary in their age, condition, and energy use, new energy conservation opportunities have been studied further in this study, to discover additional conservation methods.

IV. ENERGY CONSUMPTION

The computer simulations for the buildings in this study were done utilizing Carrier's Hourly Analysis Program (HAP) which is a building energy analysis program which utilizes hour-by-hour data to simulate the building's operation as opposed to less accurate bin-hour data. Complete documentation on the HAP program is contained in Appendix A of the report. Table 2 shows the results of the computer simulations.

TABLE 2 - ANNUAL ENERGY CONSUMPTION BY BUILDING

(Based upon computer simulation)

Building	Electrical Consumption	Natural Gas Consumption	Total Energy Consumption
1520,1521	3202.8	1156.47	4359.3
1610,1611	643.5	874.5	1518.0
Callaghan Rd.	718.1	1034.7	1752.9
Boswell St.	620.6	929.2	1549.7
Old Spanish Trail	3468.1	1968.0	5436.1
Perimeter Pk & Whse	1529.4	777.0	2306.4
Fairview Dr. & AMSA	1774.9	1244.5	3019.5

Notes:

1. All energy consumptions are in MBtu (Million Btu's).

Table 3 shows the actual energy consumption for the same buildings as metered by the San Antonio Real Property Maintenance Activity (SARPMA).

TABLE 3 - ACTUAL ENERGY CONSUMPTION BY BUILDING FY 1988

Building	Electrical Consumption	Natural Gas Consumption	Total Energy Consumption
1520,1521	3611.1	1075.9	4687.0
1610,1611	685.3	889.0	1574.3
Callaghan Rd	783.1	627.4	1410.5
Boswell St.	1005.6	1082.5	2088.1
Old Spanish Trail and Annexes B & C	4323.9	1726.8	6050.7
Perimeter Park & Warehouse	1526.2	774.6	2300.8
Fairview Dr. & AMSA	1451.8	1099.6	2551.4

<u>Notes</u>:

1. All energy consumptions are in MBtu (Million Btu's).
2. Electricity and Natural Gas Rates are included in Table 4.

TABLE 4 - ELECTRICITY AND NATURAL GAS RATES

BUILDING	Electricity		Natural Gas	
	$/KWH	$/MBTU	$/KCF	$/MBTU
1520-21 and 1610-11	0.06017	17.630	4.29955	4.170
Callaghan & Maintenance	0.05934	17.386	4.29955	4.170
Boswell	0.06643	19.464	4.29955	4.170
Perimeter Park & Maintenance	0.04974	14.574	7.35	7.129
Old Spanish Trail and Annexes B & C	0.05369	15.731	3.57745	3.470
Fairview Dr and AMSA	0.06562	19.226	5.56926	5.402

V. ENERGY USE ANALYSIS

Energy for the Army Reserve Centers is primarily maintained and governed by the San Antonio Real Property Maintenance Activity (SARPMA). The government purchases both it's electricity and natural gas through this agency. No utilities besides electricity and natural gas are used by any of the studied Reserve Centers.

In preparing the EEAP Study, utility prices from fiscal year 1988 (FY 88) were utilized. The following table shows the total cost of both energy sources for each building.

TABLE 5 - ENERGY COSTS, FY 88

(Data obtained from DEH, Fort Sam Houston)

Fuel	Quantity	Equivalent MBtu	Total Cost ($)
Bldg 1520/1521			
Electricity	1,058 MWH	3,611	63,660
Natural Gas	1,076 KCF	1,108	4,626
Bldg 1610,1611			
Electricity	201 MWH	686	12,094
Natural Gas	889 KCF	916	3,822
Callaghan Rd. & Maintenance			
Electricity	229 MWH	782	13,589
Natural Gas	627 KCF	646	2,696
Boswell Street			
Electricity	295 MWH	1,007	19,597
Natural Gas	1,083 KCF	1,115	4,656
Old Spanish Trail & Annex B & C			
Electricity	1,266 MWH	4,321	67,972
Natural Gas	1,727 KCF	1,779	6,178
Perimeter Park & Warehouse			
Electricity	447 MWH	1,526	22,234
Natural Gas	775 KCF	798	5,696
Fairview Drive and AMSA			
Electricity	425 MWH	1,452	27,889
Natural Gas	1,100 KCF	1,133	6,126

Each building's energy consumption can be further broken down into monthly increments as shown in figures 1 through 7. As expected, each building's natural gas consumption peaks in the winter months while electricity consumption peaks in the summer.

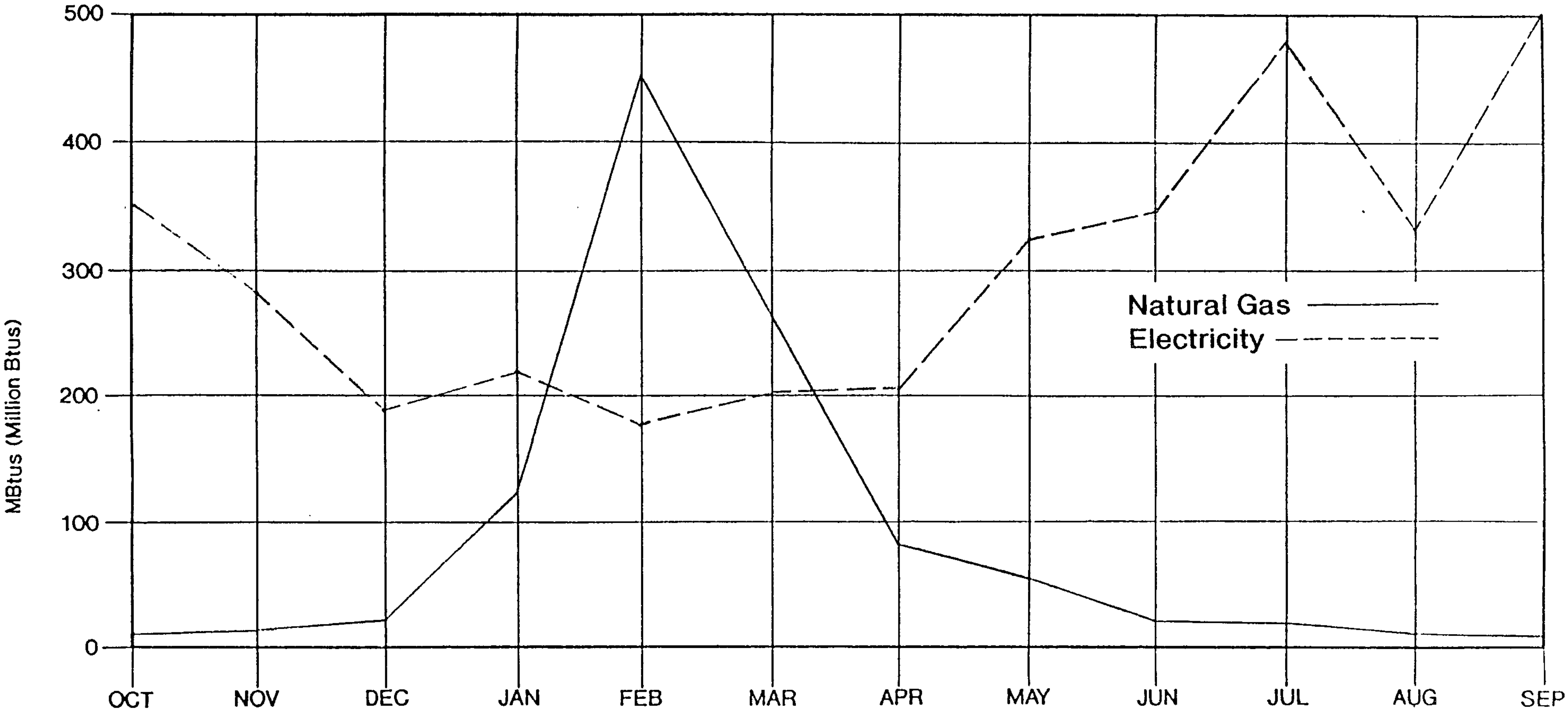

Figure 1 - Energy Consumption (Bldgs. 1520/1521) FY 1988

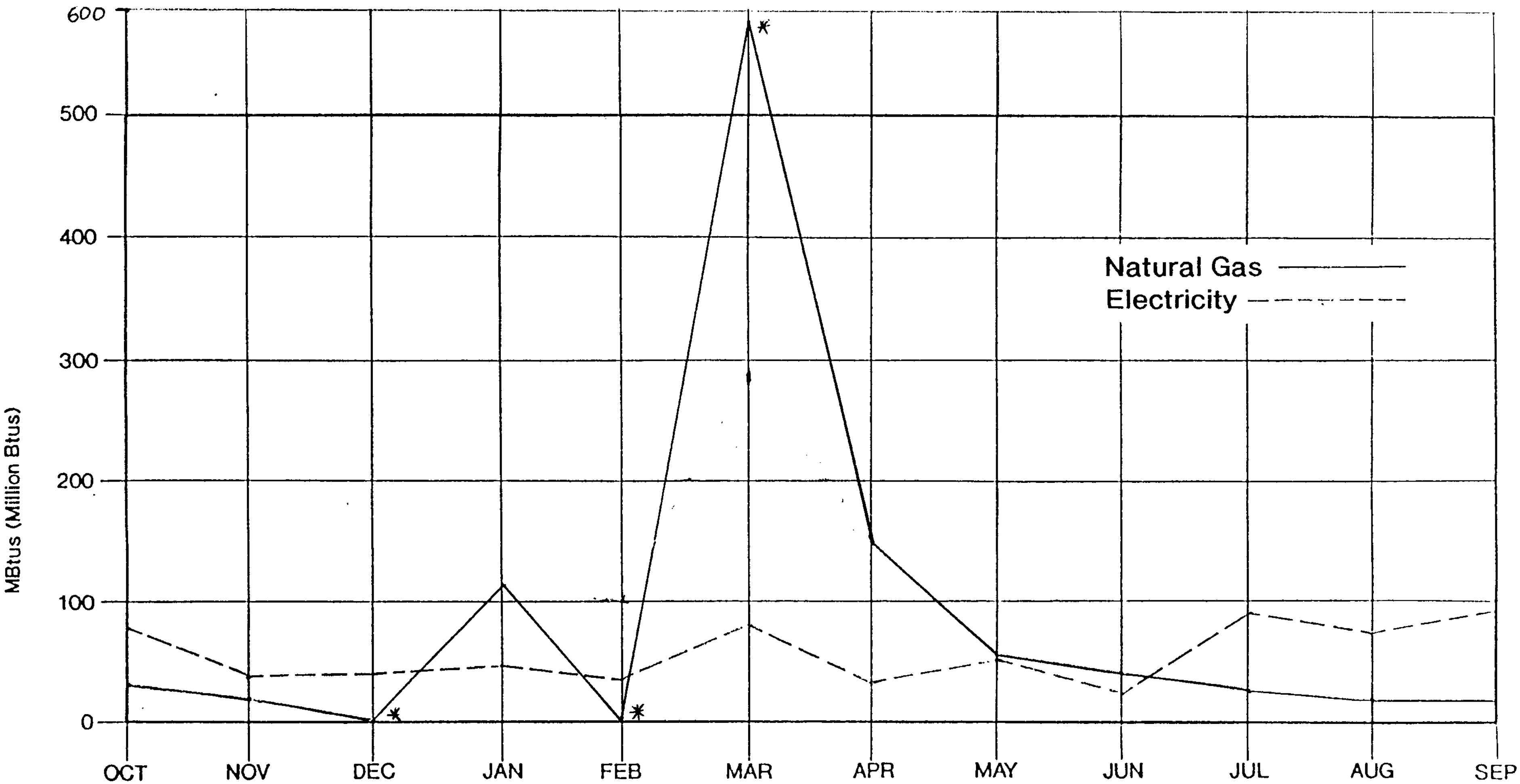

Figure 2 - Energy Consumption (Bldg. 1610) FY 1988 *The December reading of 0 was because the gas company failed to read the meter that month and the 113.200 KCF reading for January is consumption for both December and January. The February reading of 100.000 should be 0 because again the meter was not read. The March reading of 289.300 should be 589.300 and that is for both February and March.

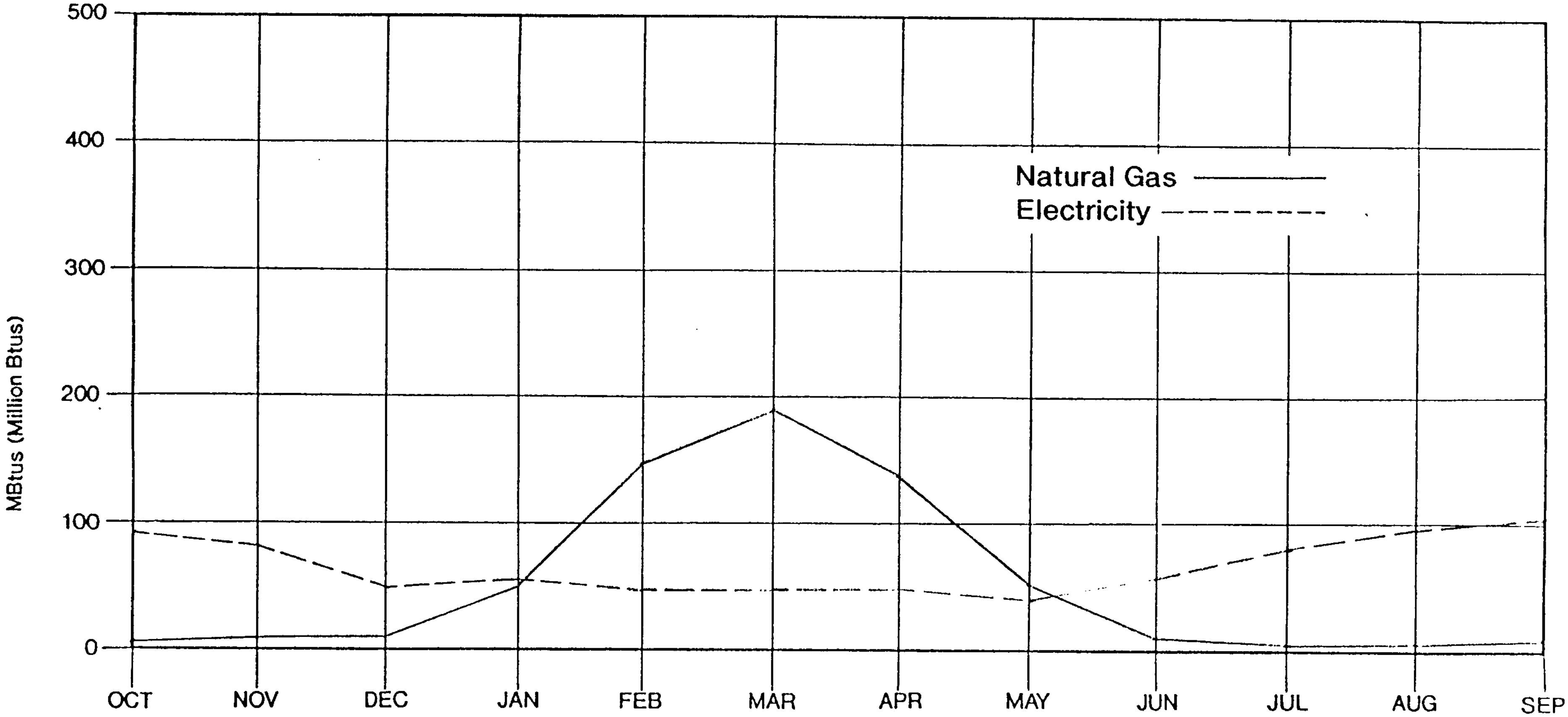

Figure 3 - Energy Consumption (Callaghan Rd.) FY 1988

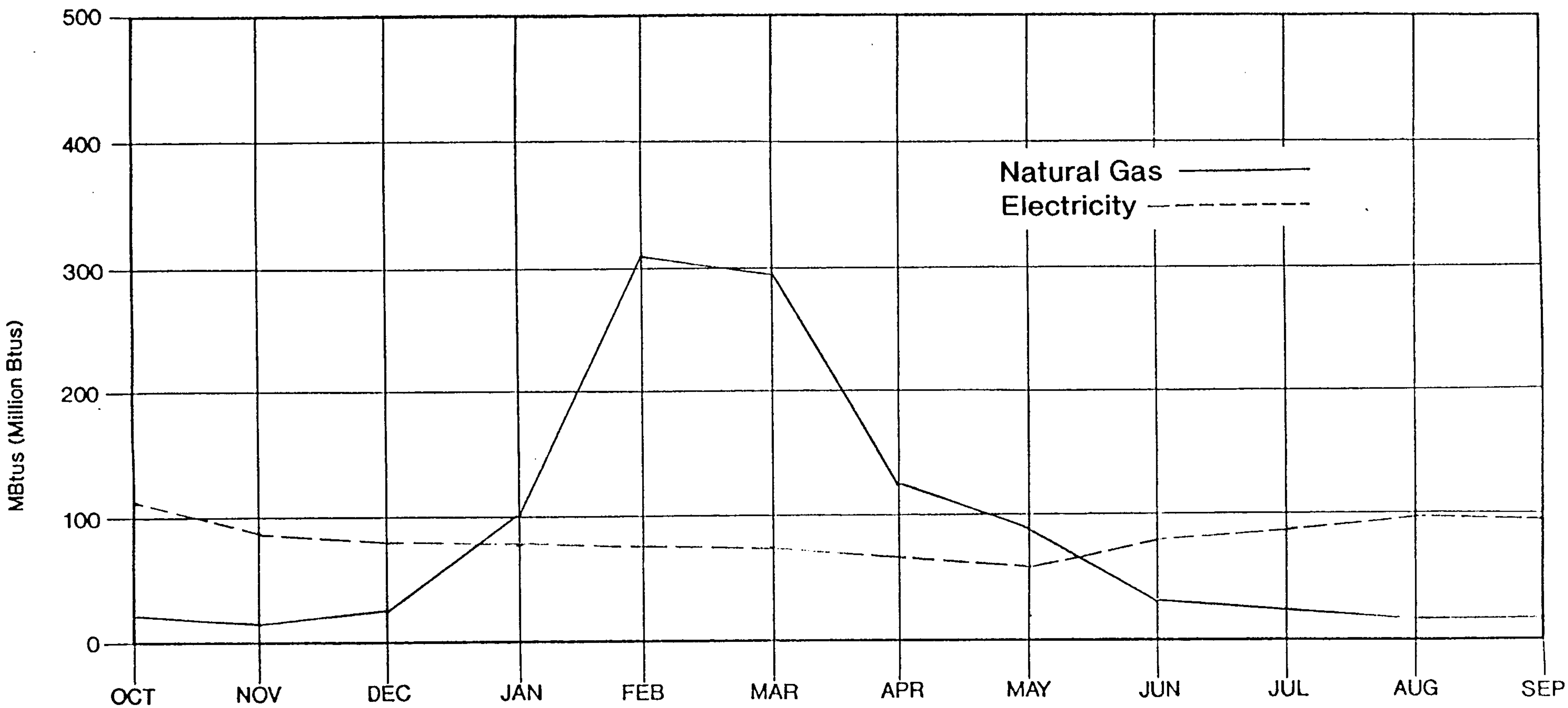

Figure 4 - Energy Consumption (Boswell Street) FY 1988

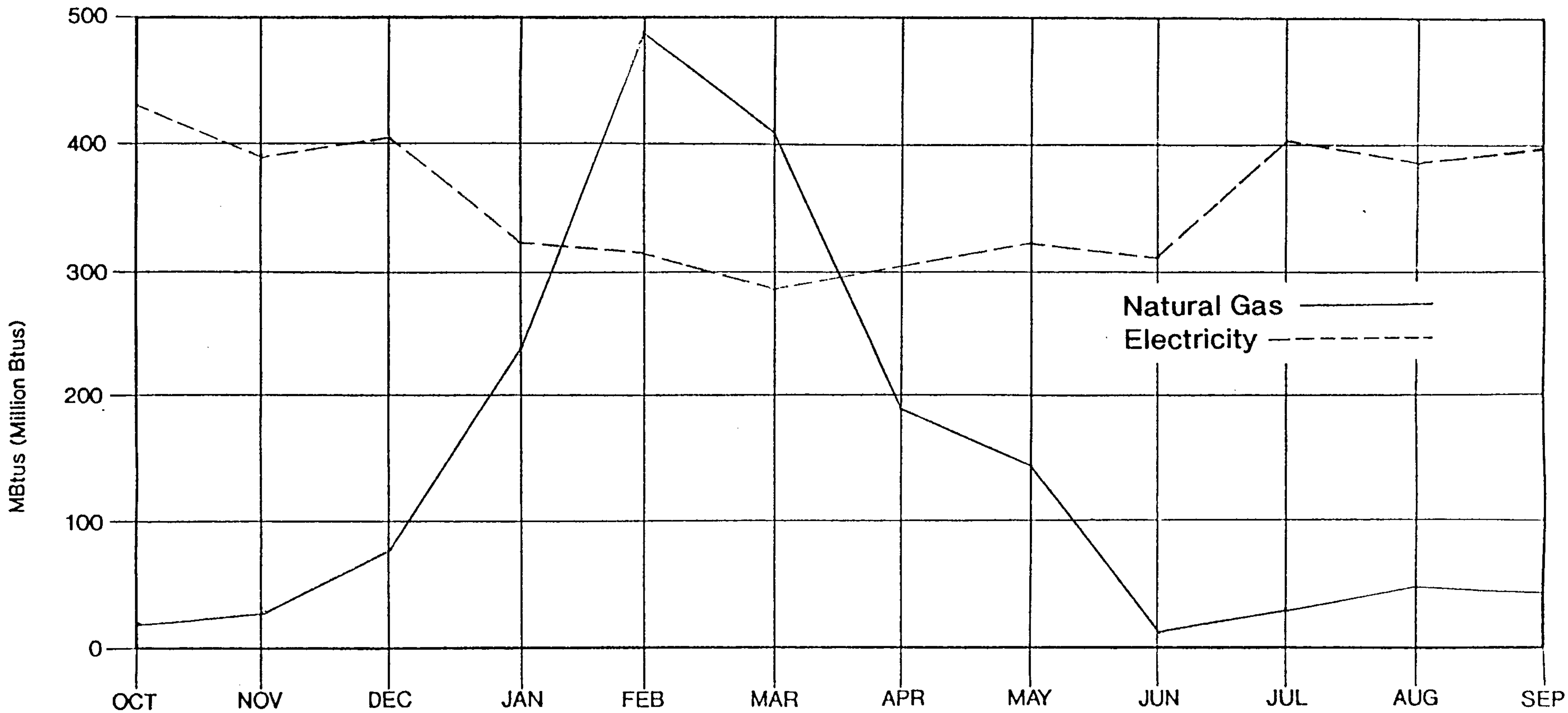

Figure 5 - Energy Consumption (Old Spanish Trail) FY 1988

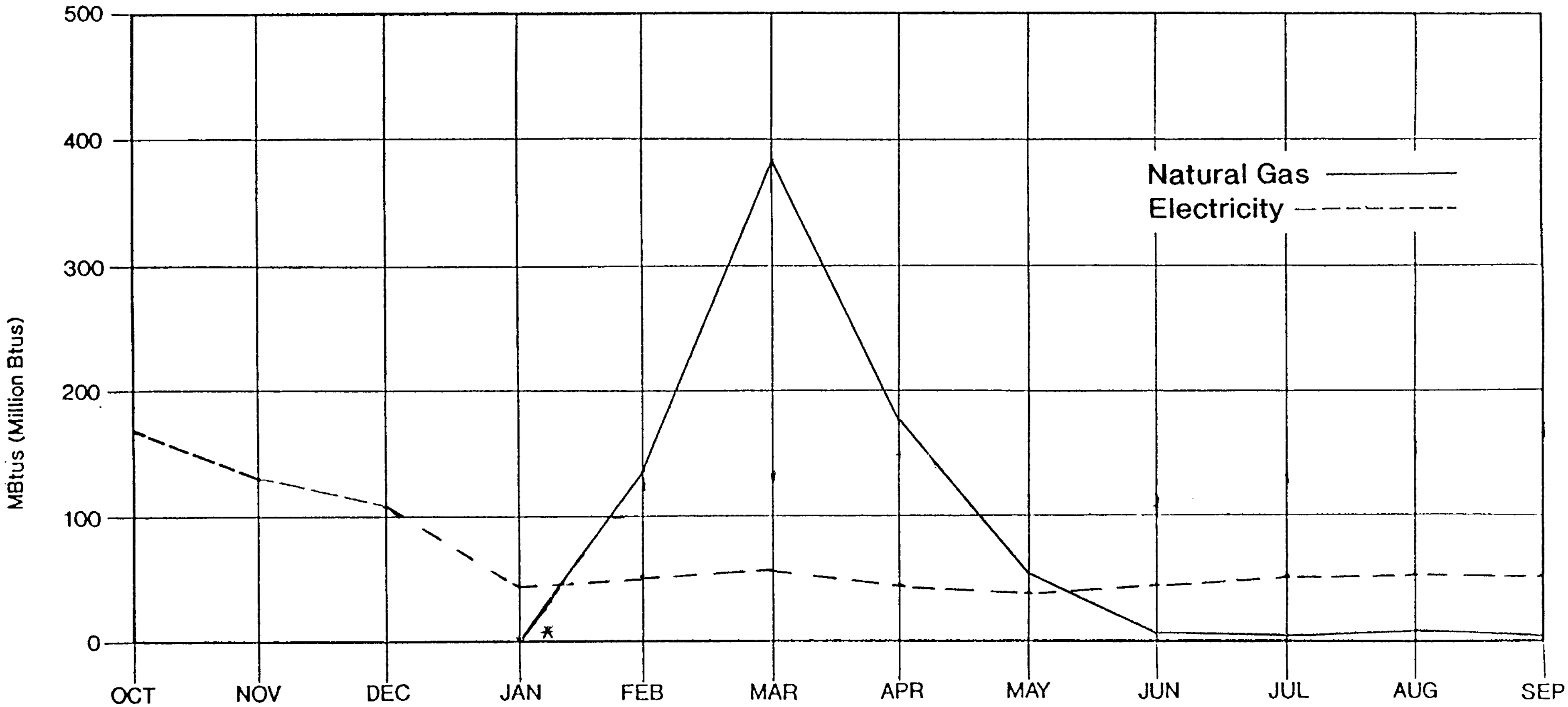

Figure 6 - Energy Consumption (Perimeter Park) FY 1988 *The 0 natural gas readings for October thru January are correct. The office areas are heated with electricity and natural gas is used only for the Warehouse and that are is only heated as necessary.

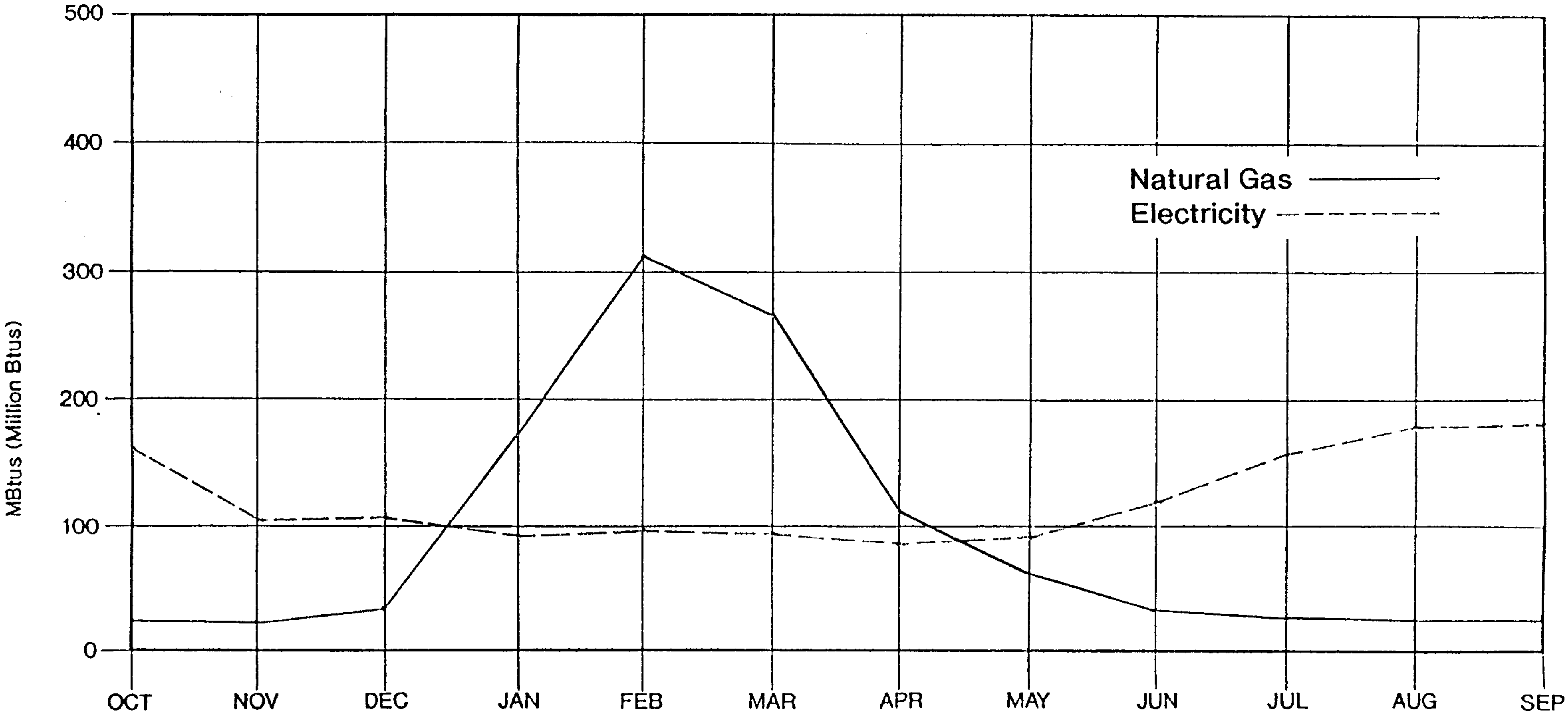

Figure 7 - Energy Consumption (Fairview Drive) FY 1988

VI. ENERGY CONSERVATION OPPORTUNITY (ECO) ANALYSIS

RECOMMENDED (FEASIBLE) ENERGY CONSERVATION OPPORTUNITIES

1. INSULATION OF THE DOMESTIC HOT WATER TANK

This ECO evaluated the savings gained when the domestic hot water storage tank or heaters were insulated. Buildings 1520, 1610, Boswell, Callaghan, Old Spanish Trail, and Perimeter Park Warehouse all had SIRs ranging from 2.72 to 4.59 and amortization periods ranging from 5.68 to 9.58 years. The construction cost ranged from $63 to $442. This ECO for these buildings is recommended for implementation.

2. DELAMP LIGHTING FIXTURES

This ECO evaluated the savings gained when lamps are removed from fixtures and ballasts are disconnected. Buildings 1520, 1521, Boswell, Old Spanish Trail Annex B, Old Spanish Trail Annex C, and Perimeter Park Warehouse all had SIRs ranging from 1.03 to 120.65 and amortization periods ranging from .11 to 12.58 years. The construction costs range from $25 to $3,626. This ECO for these buildings is recommended for implementation.

3. DELAMP AND INSTALL REFLECTORS

This ECO evaluated the savings gained when lamps and ballasts are removed from various fixtures and reflectors installed to keep the lighting level at a reasonable rate. Perimeter Park qualified for implementation with a SIR of 1.34, an amortization period of 9.65 years and a construction cost of $14,145.

4. <u>REPLACE EXIT SIGNS</u>

This ECO evaluated the savings gained when existing incandescent exit signs are replaced with electroluminescent exit signs. Buildings 1520, 1521, 1610, Boswell, Callaghan, Fairview Drive, and Fairview Drive AMSA all have SIRs ranging from 1.34 to 2.76 with amortization periods ranging from 4.70 to 9.68 years. The construction costs ranged from $419 to $3,215. This ECO for these buildings is recommended for implementation.

5. <u>INSTALL SHOWER FLOW RESTRICTORS</u>

This ECO evaluated the savings gained when show flow restrictors are installed in the showers. Buildings 1520, 1521, 1610, Boswell, Callaghan, Old Spanish Trail, Perimeter Park Warehouse, Fairview Drive, and Fairview AMSA all have SIRs ranging from 1.40 to 116.26 with amortization periods ranging from .22 to 18.62 years. The construction costs ranged from $45 to $477. This ECO for these buildings is recommended for implementation.

6. INSTALL PHOTOCELLS

This ECO evaluated the savings gained when photocells are installed in indicated areas. Buildings 1520, 1610, and Perimeter Park all had SIRs ranging from 1.65 to 18.12 and amortization periods ranging from .72 to 7.88. The construction costs range from $134 to $409. This ECO for these buildings is recommended for implementation.

7. TIMECLOCKS FOR CHILLED WATER AND HOT WATER PUMPS

This ECO evaluated the savings gained when timeclocks were installed on various pumps for sporadic operation. Buildings 1520, 1610, Old Spanish Trail, Old Spanish Trail Annex B, and Fairview Drive all have SIRs ranging from 1.86 to 1672.63 with amortization periods ranging from 0.01 to 6.99 years. The construction costs ranged from $30 to $3250. This ECO for these buildings is recommended for implementation.

8. INSTALLATION OF HI-EFFICIENCY MOTORS

This ECO evaluated the savings gained when old existing motors are replaced with new hi-efficiency motors. Buildings 1520, 1610, Boswell, Callaghan, and Fairview Drive all have SIRs ranging from 2.36 to 25.52 with amortization periods ranging from .51 to 5.50 years. The construction costs range from $89 to $187. This ECO for these buildings is recommended for implementation.

9. INSTALLATION OF OCCUPANCY SENSORS

This ECO evaluated the savings gained when occupancy sensors are installed in areas that are used infrequently. Buildings 1521, 1610, Boswell, Old Spanish Trail, Perimeter Park, Fairview Drive, Fairview Drive AMSA, and 1520 all have SIRs ranging from 1.01 to 4.17 with amortization periods ranging from 3.11 to 12.91 years. The construction costs range from $90 to $5,033. This ECO for these buildings is recommended for implementation.

10. NIGHT SETBACK

This ECO evaluated the savings gained when programmable thermostats are installed to implement night setback. All of the buildings except Building 1520 have SIRs ranging from 5.83 to 279.89 with amortization periods ranging from 0.09 to 4.20 years. The construction costs range from $383 to $9,207. This ECO for these buildings is recommended for implementation.

11. REPLACE BOILER WITH HIGHER EFFICIENCY BOILER

This ECO evaluated the savings gained when an existing boiler is replaced with a new higher efficiency boiler. Buildings 1610, Callaghan, Old Spanish Trail Annex B and Fairview Drive all have SIRs ranging from 1.0 to 10.81 with amortization periods ranging from 2.41 to 26.00 years. This ECO for these buildings is recommended for implementation.

12. <u>LOWER DOMESTIC HOT WATER TEMPERATURE</u>

This ECO evaluated the savings gained when the domestic hot water temperature was lowered. Building 1610 was evaluated for this ECO and resulted with a SIR of 79.26 and an amortization period of .33 years. The construction cost for this ECO is $25. This ECO is recommended for implementation.

13. <u>INSTALL WEATHERSTRIP ON DOORS</u>

This ECO evaluated the savings gained when weatherstripping is installed on exterior doors. Buildings 1610 has a SIR of 4.61 with a payback period of 3.61 and a construction cost of $967. Old Spanish Trail Annex B has a SIR of 1.34 with an amortization period of 19.48 years and a construction cost of $1,367. This ECO for these buildings is recommended for implementation.

14. <u>SHUTDOWN ENERGY TO DHW HEATER</u>

This ECO evaluated the savings gained when one DHW heater is put on reserve and another is installed to heat the water only when needed. Buildings 1610, Perimeter Park Warehouse, and Fairview Drive all have SIRs ranging from 1.27 to 2.28 with an amortization period ranging from 11.45 to 20.49 years. The construction cost for all three buildings is $1,696. This ECO for these buildings is recommended for implementation.

15. VARIABLE SPEED PUMPING FOR CHW PUMP

This ECO evaluated the savings gained when a variable speed drive was installed on a CHW pump. Building 1610, with its SIR of 125.67, payback period of .15 years, and a construction cost of $288 qualified for this ECO. This ECO is recommended for implementation.

16. REPLACE INCANDESCENT LIGHTS AND INSTALL PHOTOCELL

This ECO evaluated the savings gained when incandescent lights are replaced with fluorescent and photocells are installed. Building 1611 with a SIR of 1.69, an amortization period of 7.68 years along with Callaghan Maintenance's SIR of 1.67 and payback period of 7.79 years qualify for this ECO. Both buildings construction cost is $301. This ECO for these buildings is recommended for implementation.

17. REPLACE ENTRYWAY LIGHTS

This ECO evaluated the savings gained when the existing incandescent entryway lights were replaced with fluorescent lights. Callaghan Building, with its SIR of 1.40, amortization period of 9.29 years, and construction cost of $565 qualified for this ECO. This ECO is recommended for implementation.

18. <u>REPLACE EXISTING UNIT HEATERS</u>

This ECO evaluated the savings gained when existing gas fired unit heaters are replaced with gas fired infrared heaters. Buildings 1611, Callaghan Maintenance, Perimeter Park Warehouse, and Fairview Drive AMSA all have SIRs ranging from 3.62 to 26.63 and amortization period ranging from .96 to 6.27 years. The construction costs range from $2,962 to $7,747. This ECO for these buildings is recommended for implementation.

19. <u>INSTALL CHILLER PRE-COOLERS</u>

This ECO evaluated the savings gained when pre-coolers were installed before the condenser on chillers. Old Spanish Trail with its SIR of 1.49, amortization period of 8.68 years, and construction cost of $14,080, qualified for this ECO. This ECO is recommended for implementation.

20. <u>INSULATE HW COIL HEADERS</u>

This ECO evaluated the savings gained through the insulation of the HW coil headers that are present in the supply duct. Old Spanish Trail, with its SIR of 10.57, amortization period of 8.68 years, and construction cost of $497, qualified for this ECO. This ECO is recommended for implementation.

21. DISABLE AIR CONDITIONING

This ECO evaluated the savings gained by turning the air conditioning system off at Old Spanish Trail Annex B since it was not needed. Old Spanish Trail Annex B with its SIR of 1262.61, amortization period of 0.01 years, and construction cost of $25 had no problem qualifying. This ECO is recommended for implementation.

All ECO's addressed in this study are grouped by building and presented in the order stated earlier. Site investigation of each building was undertaken before ECO calculations were performed in order to eliminate nonfeasible ECO's before needless calculations were made. Detailed summaries and calculations of all ECOs, both feasible and non-feasible, can be found in Section 2.

When determining which ECO's would be feasible to study, the checklist which appears as Annex A in the Scope of Work was used as a basis. Each possible ECO was checked as either applicable or not applicable for each building. These checklists for each builidng are presented in Section 2 of the report. All possible ECO's which were checked as not applicable, were checked as such for one or more of the following reasons:

1. The possible ECO pertained to systems which did not exist in the building such as steam, cooling towers, and centrifugal chillers.

2. The possible ECO recommended alterations to a system which would sacrifice personnel comfort such as reduced lighting levels, lower temperatures, higher temperatures, and/or less air flow.

3. The possible ECO was already in place in the building.

All remaining possible ECO's were checked as applicable and were therefore studied and appear in this report.

According to the Scope of Work (which is presented as Appendix E), all feasible ECO's fall into one of the following three categories:

1. MMCAR Projects
2. Non MMCAR Projects
3. Nonfeasible Projects

Feasible ECO's are those ECO's which show a Savings to Investment Ratio (SIR) of greater than one in which both MMCAR and Non MMCAR projects are made up of ECO's with SIR's greater than or equal to one. Table 6 shows all ECO's which were calculated and deemed feasible; therefore their implementation is recommended.

TABLE 6 - FEASIBLE ENERGY CONSERVATION OPPORTUNITIES

BUILDING	ECO NAME	SIR	PAYBACK (YRS)	CONSTRUCTION COST	ENERGY SAVINGS MBTU/YR ELEC	ENERGY SAVINGS MBTU/YR GAS	ANNUAL ENERGY($) SAVINGS
1520	Insulate DHW Tank	3.23	8.06	203*	0.	6.25	26
	Reduce Light Level in Assembly	13.27	.98	50*	3.	0.	53
	Replace Exit Signs	1.61	8.04	3,215	22.65	0.	399
	Shower Flow Limiters	116.26	.22	91*	0.	100.8	420
	Install Photocell On Existing Lights	18.12	.72	134	10.98	0.	194
	Timeclock for Chiller CHW & HW Pumps	3.26	2.72	3,250	76.90	<39.18>	1,192
	Install Hi-Efficiency Motors	25.52	.51	187*	21.58	0.	380
	Delamp Lighting Fixtures in Corridors	1.03	12.58	3,626	16.33	0.	288
	Delamp Lighting Fixtures in Rooms 111 and 136	3.10	4.19	1,812	24.5	0.	432
	Occupancy Sensors in Classrooms	2.14	6.06	5,033	47.	0.	830
	DHW Circulation Pump Control	1.86	6.99	81	.68	0.	12
1521	Occupancy Sensors Break Room	4.17	3.11	90	1.55	0.	27
	Occupancy Sensors Restrooms	1.27	10.26	180	1.03	0.	18
	Replace Exit Signs	1.56	8.31	419	2.96	0.	52
	Delamp Lighting Fixtures in Rm B	16.34	.79	51*	3.77	0.	66

TABLE 6 - FEASIBLE ENERGY CONSERVATION OPPORTUNITIES

BUILDING	ECO NAME	SIR	PAYBACK (YRS)	CONSTRUCTION COST	ENERGY SAVINGS MBTU/YR ELEC	ENERGY SAVINGS MBTU/YR GAS	ANNUAL ENERGY($) SAVINGS
1521 (continued)	Night Setback	5.83	4.20	9,207	15.	4.62	2,256
	Shower Flow Limiters	77.22	0.34	137*	0.	100.8	420
1610	Add Insulation to DHW Tank	2.72	9.58	442*	0.	11.10	48
	Photocells in Stairwells	1.65	7.88	409	3.047	0.	54
	Replace Boiler with Higher Efficiency Boiler	2.35	11.08	8,771	0.	189.7	791
	Replace Exit Signs	1.34	9.68	2,098	12.28	0.	216
	Lower Domestic Hot Water Temperature	79.26	.33	25*	0.	18.88	79
	Occupancy Sensors	2.96	4.38	180	2.41	0.	42
	Shower Flow Limiters	7.10	3.67	272*	0.	18.4	79
	Install Weatherstrip on Front Doors	4.61	3.61	967*	11.36	18.52	278
	Shutdown Energy to Water Heater	2.28	11.45	1,696	0.	35.5	148
	Variable Speed Pumping for Chilled Water Pump	1.83	7.11	2,444	19.49	0.	344
	Timeclock for Chiller, CHW and HW Pumps	25.7	0.49	914	55.04	228.89	1,925
	Hi-Efficiency Motors	2.36	5.50	120*	1.28	0.	23

TABLE 6 - FEASIBLE ENERGY CONSERVATION OPPORTUNITIES

BUILDING	ECO NAME	SIR	PAYBACK (YRS)	CONSTRUCTION COST	ENERGY SAVINGS MBTU/YR		ANNUAL ENERGY($) SAVINGS
					ELEC	GAS	
1610 (continued)	Night Setback	9.73	1.38	4,255	64.	467	3,076
1611	Replace Incandescent Light and Install Photocell	1.69	7.68	301	2.3	0.	41
	Night Setback	19.47	.78	383	2.20	112.76	509
	Replace Unit Heaters with Infrared Heaters	2.25	6.25	2,962	7.	84.	467
Boswell	Occupancy Sensors	1.03	12.55	361	1.53	0.	30
	Add Insulation to DHW Tank	3.13	8.32	123*	0.	3.67	15
	Replace Exit Signs	1.72	7.55	978	6.89	0.	134
	Delamp 20%	11.32	1.15	75*	3.479	0.	68
	Shower Flow Restrictors	7.86	3.32	477*	0.	35.7	149
	Hi-Efficiency Motors	8.61	1.51	89*	3.14	0.	61
	Night Setback	25.94	.5	2,495	109.	677.	5,025
Callaghan	Add Insulation to DHW Heater	3.72	7.00	137*	0.	4.86	20
	Replace Exit Sign	2.76	4.70	1,485	18.15	0.	316
	Shower Flow Restrictors	6.85	3.80	409*	0.	26.7	111
	Replace Entryway Lights	1.40	9.29	565*	3.62	0.	63
	Night Setback	29.74	.41	1,250	106.	296.	3,078

TABLE 6 - FEASIBLE ENERGY CONSERVATION OPPORTUNITIES

BUILDING	ECO NAME	SIR	PAYBACK (YRS)	CONSTRUCTION COST	ENERGY SAVINGS MBTU/YR ELEC	ENERGY SAVINGS MBTU/YR GAS	ANNUAL ENERGY($) SAVINGS
Callaghan (continued)	Hi-Efficiency Motors	7.69	1.69	89*	3.14	0.	55
	Hi-Efficiency Boiler	2.64	9.88	6,184	0.	150.	626
Callaghan Maintenance	Night Setback	19.45	.78	383	2.2	112.76	508
	Infrared Heaters	2.29	6.08	2,962	7.	84.	487
	Replace Incandescent Lights and Install Photocell	1.67	7.79	301	2.3	0.	40
Old Spanish Trail	Chiller Pre-coolers	1.12	8.68	14,081	102.97	0.	1,620
	Occupancy Sensors	1.01	12.91	361	1.84	0.	29
	Insulate DHW Tank	3.08	8.47	142*	0.	5.0	17
	Shower Flow Restrictors	15.65	1.66	149*	0.	26.7	93
	Insulate HW Coil Headers	10.57	2.46	497	0.	60.15	209
	Timeclock for DHW Pump	8.16	1.59	81	3.35	0.	53
OST Annex B	Delamp Fixtures	6.30	2.06	240*	7.667	0.	121
	Disable Air Conditioner	786.25	0.01	25	160.	0.	2,517
	Timeclock	157.83	0.08	30*	24.0	0.	378
	Replace Boiler with Higher Efficiency Boiler	10.81	2.41	3,498	0.	418.0	1,450
	Weatherstrip on Doors	1.34	19.48	1,367*	0.	20.2	70

TABLE 6 - FEASIBLE ENERGY CONSERVATION OPPORTUNITIES

BUILDING	ECO NAME	SIR	PAYBACK (YRS)	CONSTRUCTION COST	ENERGY SAVINGS MBTU/YR ELEC	ENERGY SAVINGS MBTU/YR GAS	ANNUAL ENERGY($) SAVINGS
OST Annex C	Delamp in Office Area	26.93	.48	25*	3.413	0.	54
Perimeter Park	Install Photocell	3.26	3.98	134	2.39	0.	34
	Occupancy Sensors	1.16	11.19	271	1.72	0.	25
	Night Setback	7.32	1.32	5,430	281.	0.	4,094
	Delamp and Install Reflectors	1.34	9.65	14,145	100.47	0.	1,464
Perimeter Park Whse	Shutdown Energy to DHW Heater	1.27	20.49	1,696	0.	116.5	83
	Night Setback	85.79	0.18	499	15.	763.	5,658
	Shower Flow Restrictors	37.08	0.7	45*	0.	9.3	66
	Delamp in Assembly Area	120.65	0.11	100*	66.01	0.	962
	Insulate DHW Tank	4.59	5.68	63*	0.	1.61	11
	Replace Unit Heaters with Infrared Heaters	6.17	2.44	7,747	24.34	1085.	8,091
Fairview Drive	Occupancy Sensors	1.85	7.02	180	1.38	0.	27
	Replace Exit Signs	1.76	7.38	1,118	7.87	0.	151
	Timeclock for DHW Circulation Pump	4.44	2.92	163	3.02	0.	58
	Hi-Efficiency Motors	23.08	.56	91*	8.71	0.	167

TABLE 6 - FEASIBLE ENERGY CONSERVATION OPPORTUNITIES

BUILDING	ECO NAME	SIR	PAYBACK (YRS)	CONSTRUCTION COST	ENERGY SAVINGS MBTU/YR ELEC	ENERGY SAVINGS MBTU/YR GAS	ANNUAL ENERGY($) SAVINGS
Fairview Drive (continued)	Shutdown Energy to DHW Heater	2.06	12.65	1,696	0.	24.8	134
	Shower Flow Restrictors	10.32	2.52	137*	0.	10.40	56
	Timeclock for Chiller CHW & HW Pumps	953.10	0.01	30*	99.	132.	2,617
	Replace Boiler with Higher Efficiency Boiler	1.00	26.00	6,184	0.	44.	238
	Night Setback	12.81	0.97	3,739	106.	333.	3,837
Fairview Drive AMSA	Shower Flow Restrictors	1.40	18.62	137*	0.	1.41	8
	Occupancy Sensors	1.85	7.02	180	1.38	0.	27
	Night Setback	67.53	0.21	709	34.	492.	3,311
	Replace Unit Heater with Infrared Heaters	2.84	5.36	7,747	4.89	250.	1,444
	Replace Exit Signs	1.70	7.62	419	2.96	0.	57

*Represents Low Cost Projects

TABLE 6A - FEASIBLE ENERGY CONSERVATION OPPORTUNITIES RANKED BY SIR

BUILDING	ECO NAME OR DESCRIPTION	CONST. COST $	PAYBACK	SIR
Fairview Drive	Timeclock for chiller, CHW and HW Pumps	30	0.01	953.10
OST Annex B	Disable air conditioning	25	0.01	786.25
1520	Timeclock for chiller, CHW and HW Pumps	30	.03	157.83
Perimeter Park Whse	Delamp in assembly	100	.11	120.65
1520	Shower flow restrictors	91	.22	116.26
Perimeter Park Whse	Night setback	499	.13	85.79
1610	Lower domestic hot water temperature	25	.33	79.26
1521	Shower flow restrictors	137	.34	77.22
Drive AMSA	Night setback	709	.22	67.53
Park Whse	Shower flow restrictors	45	0.7	37.08
Callaghan	Night setback	1,250	.41	29.74
OST Annex C	Delamp in office area	25	.48	26.93
Boswell	Night setback	2,495	0.5	25.94
1610	Timeclock for chiller, CHW and HW pumps	914	.15	25.7
1520	Hi-eff. motors installation	187	.51	25.52
Fairview Drive	Hi-eff. motors	91	.56	23.08
1611	Night setback	383	.78	19.47
Callaghan Maint.	Night setback	383	.78	19.45
1520	Install photocells on exterior lights	134	.72	18.12
1521	Delamp lighting fixtures in Room B	51	.79	16.34
Old Spanish Trail	Shower flow restrictors	149	1.66	15.65
1520	Reduce light level in assembly	50	.98	13.27
Fairview Drive	Night setback	3,739	0.97	12.81

TABLE 6A - FEASIBLE ENERGY CONSERVATION OPPORTUNITIES RANKED BY SIR (Continued)

BUILDING	ECO NAME OR DESCRIPTION	CONST. COST $	PAYBACK	SIR
Boswell	Delamp 20%	75	1.15	11.32
OST Annex B	Replace boiler with high efficiency	3,498	2.41	10.81
Old Spanish Trail	Insulate HW coil headers	497	2.46	10.57
Fairview Drive	Shower flow restrictors	137	2.52	10.32
1610	Night setback	4,255	1.38	9.73
Boswell	Hi-eff. motors	89	1.51	8.61
Old Spanish Trail	Timeclock for DHW pump	81	1.59	8.16
Boswell	Shower flow restrictors	477	3.32	7.86
Callaghan	Hi-eff. motors	89	1.69	7.69
Perimeter Park	Night setback	5,430	1.32	7.32
1610	Shower flow restrictors	272	3.67	7.10
Callaghan	Shower flow restrictors	409	3.80	6.85
OST Annex B	Delamp fixtures	240	2.06	6.30
Fairview Park Whse	Replace unit heaters with infrared heaters	7,747	2.44	6.17
1521	Night setback	9,207	4.20	5.83
1610	Install weatherstrip on front doors	967	3.61	4.61
Park Whse	Insulate DHW tank	63	5.68	4.59
Fairview Drive	Timeclock for DHW circulating pump	163	2.92	4.44
1521	Occupancy sensors	90	3.11	4.17
Callaghan	Add insulation to DHW tank	137	7.00	3.72
Perimeter Park	Install photocell	134	3.98	3.26
1520	Insulate DHW tank	203	8.06	3.23
Boswell	Add insulation to DHW tank	123	8.32	3.13
1520	Delamp lighting fixtures in Rooms 111 & 136	1,812	4.19	3.10
Old Spanish Trail	Insulate DHW tank	142	8.47	3.08

TABLE 6A - FEASIBLE ENERGY CONSERVATION OPPORTUNITIES RANKED BY SIR (Continued)

BUILDING	ECO NAME OR DESCRIPTION	CONST. COST $	PAYBACK	SIR
1610	Occupancy sensors	180	4.38	2.96
Fairview Drive AMSA	Replace unit heaters with infrared heaters	7,747	5.36	2.84
Callaghan	Exit signs	1,485	4.70	2.76
1610	Add insulation to DHW tank	442	9.58	2.72
Callaghan	Hi-eff. boiler	6,184	9.88	2.64
1610	Hi-eff. motors	120	5.50	2.36
1610	Replace boiler with higher efficiency boiler	8,771	11.08	2.35
Callaghan Maint.	Infrared heaters	2,962	6.08	2.29
1610	Shutdown energy to water heater	1,696	11.45	2.28
1611	Replace unit heaters with infrared heaters	2,962	6.25	2.25
1520	Occupancy sensors (Class)	5,033	6.06	2.14
Fairview Drive	Shutdown energy to DHW heater	1,696	12.65	2.06
1520	DHW circ. pump control	81	6.99	1.86
Fairview Drive AMSA	Occupancy sensors	180	7.02	1.85
Fairview Drive	Occupancy sensors	180	7.02	1.85
1610	Variable speed pumping for chilled water pump	2,444	7.11	1.83
Fairview Drive	Replace exit signs	1,118	7.38	1.76
Boswell	Replace exit signs	978	7.55	1.72
Fairview Drive AMSA	Replace exit signs	419	7.62	1.70
1611	Replace incandescent lights and install photocell	301	7.68	1.69
Callaghan Maint.	Replace incandescent lights and install photocell	301	7.79	1.67
1610	Photocells in stairwells	409	7.88	1.65
1520	Replace exit signs	3,215	8.04	1.61
1521	Replace exit signs	419	8.31	1.56

TABLE 6A - FEASIBLE ENERGY CONSERVATION OPPORTUNITIES RANKED BY SIR (Continued)

BUILDING	ECO NAME OR DESCRIPTION	CONST. COST $	PAYBACK	SIR
Callaghan	Entryway lights	565	9.39	1.40
Fairview Drive AMSA	Shower flow restrictors	137	18.62	1.40
Perimeter Park	Delamp and install reflectors	14,145	9.65	1.34
1610	Replace exit signs	2,098	9.68	1.34
OST Annex B	Weatherstrip on doors	1,367	19.48	1.34
1521	Occupancy sensors	180	10.26	1.27
Perimeter Park Whse	Shutdown energy to DHW	1,696	20.49	1.27
Perimeter Park	Occupancy sensors	271	11.19	1.16
Old Spanish Trail	Chiller pre-coolers	14,081	8.68	1.12
1520	Delamp lighting fixtures in corridors	3,626	1.03	1.03
Boswell	Occupancy sensors	361	12.55	1.03
Old Spanish Trail	Occupancy sensors	361	12.91	1.01
Fairview Drive	Replace boiler with higher efficiency boiler	6,184	26.00	1.00

Table 7 shows all remaining ECO's which are the nonfeasible ECO's since their SIR is less than one. Therefore, the implementation of these ECO's is not recommended.

TABLE 7 - NON-FEASIBLE ENERGY CONSERVATION OPPORTUNITIES

BUILDING	ECO NAME	SIR	PAYBACK (YRS)	CONSTRUCTION COST	ENERGY SAVINGS MBTU/YR ELEC	ENERGY SAVINGS MBTU/YR GAS	ANNUAL ENERGY($) SAVINGS
1520	Insulate CHW Tank	0.24	54.42	343	.37	0.	7
	Add Vestibule to Entryway	0.10	219.98	8,858	0.82	6.18	40
	Replace Chiller with Higher Efficiency Chiller	0.04	257.67	90,946	19.97	0.	352
	Install Pre-Cooler on Air Cooled Chillers	0.53	18.31	11,632	35.64	0.	628
	Occupancy Sensors	0.73	17.66	361	1.2	0.	21
	Pipe Chillers in Parallel	0.28	34.44	12,765	21.	0.	370
1521	Economizer for Upflow Furnace Air System	0.70	183.99	2,630	.81	0.	14
1610	Replace Chiller with Higher Efficiency Chiller	0.28	34.79	44,210	72.	0.	1,269
	Install Pre-Cooler on Air Cooled Chillers	0.39	24.60	3,907	9.36	0.	165
	Solar Film to Windows	0.89	20.16	14,585	25.38	65.99	723
	Install Double Pane Windows	0.49	62.22	43,643	<13.>	233.	733
1611	Install Double Pane Windows	0.08	262.61	3,787	0.24	2.44	14
Boswell	Install Pre-Cooler on Air Cooled Chillers	0.53	18.23	3,907	10.80	0.	210
	Replace Old Fixtures with New Low Wattage Lamps and Ballasts	0.22	59.69	9,060	7.79	0.	152

TABLE 7 - NON-FEASIBLE ENERGY CONSERVATION OPPORTUNITIES

BUILDING	ECO NAME	SIR	PAYBACK (YRS)	CONSTRUCTION COST	ENERGY SAVINGS MBTU/YR ELEC	ENERGY SAVINGS MBTU/YR GAS	ANNUAL ENERGY($) SAVINGS
Boswell	Electronic Ballasts	0.26	50.88	19,141	19.31	0.	376
	Timeclock for DHW Pump	0.29	44.23	163	.196	0.	4
	Install Double Pane Windows	0.22	109.99	69,941	5.	129.	649
Callaghan	Install Pre-Cooler on Air Cooled Chillers	0.18	53.61	4,666	4.85	0.	84
	Occupancy Sensors	0.87	14.93	474	1.89	0.	33
	Low Wattage Lamps and Ballasts	0.11	113.84	19,693	9.94	0.	173
	DHW Pump Control	0.26	49.19	81	.098	0.	2
Callaghan Maint.	Install Double Pane Windows	0.08	263.69	3,787	.24	2.44	14
Old Spanish Trail	Economizers for AHU's	0.49	12.59	21,586	173.85	<295.>	1,711
	Replace Chiller with Higher Efficiency Chiller	0.57	16.90	85,703	322.	0.	5,065
OST Annex B	Install Double Pane Windows	0.08	337.99	4,696	0.	4.0	14
OST Annex C	Install Pre-Cooler on Air Cooled Chillers	0.38	25.37	3,995	10.239	0.	161
	Occupancy Sensors	0.88	14.80	121	.538	0.	8
Perimeter Park	Install Double Pane Windows	0.19	67.36	37,991	38.67	0.	563
	Gas Heat for RTUs	<0.13>	71.44	50,290	203.	<316.>	703
	RTUs with Economizer	0.20	49.70	45,667	63.	0.	918
	Add Vestibule to Entry	0.10	127.97	5,711	3.06	0.	45

TABLE 7 - NON-FEASIBLE ENERGY CONSERVATION OPPORTUNITIES

BUILDING	ECO NAME	SIR	PAYBACK (YRS)	CONSTRUCTION COST	ENERGY SAVINGS MBTU/YR ELEC	ENERGY SAVINGS MBTU/YR GAS	ANNUAL ENERGY($) SAVINGS
Fairview Drive	Install Pre-Cooler on Air Cooled Chillers	0.70	13.85	6,673	25.03	0.	481
	Replace Lighting Fixtures in Second Floor Offices	0.20	65.91	6,128	4.83	0.	93
Fairview Drive AMSA	Install Double Pane Windows	0.02	537.01	10,337	1.0	0.	19
	Add Solar Film to Windows	0.27	47.56	1,831	2.0	0.	38

VII. EMCS ANALYSIS

An EMCS study was performed on each building independent of the ECO analyses in order to determine the economic feasibility of stand-alone EMCS systems for each building, except Buildings 1520, 1521, and 1610. The study on these buildings analyzed the feasibility of tying into the basewide EMCS system at Ft. Sam Houston. The results of the EMCS study were as follows:

BUILDINGS 1520, 1521, & 1610

Total Energy Savings	=	235	MBtu/Year
First Year Cost Avoidance	=	$2,517	
Construction Cost	=	$82,328	
SIR	=	0.48	
Payback	=	33	Years

CALLAGHAN ROAD

Total Energy Savings	=	131	MBtu/Year
First Year Cost Avoidance	=	$1,864	
Construction Cost	=	$83,129	
SIR	=	0.31	
Payback	=	45	Years

BOSWELL STREET

Total Energy Savings	=	156	MBtu/Year
First Year Cost Avoidance	=	$1,338	
Construction Cost	=	$82,851	
SIR	=	0.28	
Payback	=	62	Years

OLD SPANISH TRAIL

Total Energy Savings	=	452	MBtu/Year
First Year Cost Avoidance	=	$4,947	
Construction Cost	=	$84,950	
SIR	=	0.85	
Payback	=	17	Years

PERIMETER PARK

Total Energy Savings	=	251	MBtu/Year
First Year Cost Avoidance	=	$3,056	
Construction Cost	=	$101,001	
SIR	=	0.47	

FAIRVIEW DRIVE

Total Energy Savings	=	338	MBtu/Year
First Year Cost Avoidance	=	$3,377	
Construction Cost	=	$113,590	
SIR	=	0.53	
Payback	=	34	Years

It is therefore recommended that stand-alone EMCS systems not be installed in the buildings located at Callaghan Road, Boswell Street, Old Spanish Trail, Perimeter Park, and Fairview Drive. It is further recommended that the tie-in to the basewide EMCS system for Buildings 1520, 1521, and 1610 not be implemented.

TABLE 8 - EMCS RESULTS

BUILDING	ENERGY SAVINGS MBTU/YR	COST SAVINGS $	EST COST $	SIR	PAYBACK (YEARS)
1520,1521 1610*	235	2,517	82,328	0.48	33
CALLAGHAN	131	1,864	83,129	0.31	45
BOSWELL	156	1,338	82,851	0.28	62
SPANISH TRAIL	452	4,947	84,950	0.85	17
PERIMETER PARK	251	3,056	101,001	0.47	33
FAIRVIEW	338	3,377	113,590	0.53	34

*BASE WIDE TIE-IN

VIII. RECOMMENDED PROJECTS

All energy conservation opportunities (ECOs) that were studied and found to be feasible were evaluated for the projects. In the case of overlapping or redundant ECOs, the less effective ECO was eliminated from the project for that building. The interactive effects of the remaining ECOs were calcuated and these results were used to determine the overall savings for the projects. Tables 9 through 12 show the ECOs recommended for the projects. Some ECOs which were previously calculated as separate projects, have been combined in order to determine their combined effect.

1. Low Cost Projects: Feasible Energy Conservation Opportunities for all of the buildings in the study which the supporting Installations DEH or USAR Personnel can implement with their own resources. ECOs that were redundant or overlapped those recommended for the individual building were eliminated from this project. The interactive effects of these ECOs and those recommended for Projects A through C were calculated and the results adjusted accordingly.

2. Project A: Feasible ECOs that are not redundant or low cost ECOs for Buildings 1520, 1521, 1610, and 1611 which are located in San Antonio.

3. Project B: Feasible ECOs that are not redundant or low cost ECOs for Old Spanish Trail, Old Spanish Trail

Annex B, Perimeter Park, and Perimeter Park Warehouse, which are located in Houston.

4. Project C: Feasible ECOs that are not redundant or low cost ECOs for Fairview Drive and Fairview Drive AMSA, which are located in Austin.

5. Project D: Projects A, B, and C combined.

Project A (San Antonio) falls under the category of a non MMCAR project as a Productivity Enhancing Capitol Investment Program (PECIP) which is for projects that have a total construction cost of more than $3,000.00 and a simple payback period of four years or less. Project A has a total construction cost of $59,595.00, a simple payback period of 3.33 years, and a SIR of 2.86.

Project B (Houston) falls under the category of a non MMCAR project as a Productivity Enhancing Capitol Investment Program (PECIP) which is for projects that have a total construction cost of more than $3,000.00 and a simple payback period of four years or less. Project B has a construction cost of $46,275.00, a simple payback period of 3.42 years, and a SIR of 2.78.

Project C (Austin) falls under the category of a non MMCAR project as a Productivity Enhancing Capitol Investment Program (PECIP) which are for projects that have a total construction cost of more than $3,000.00 and a simple payback period of four years or less. Project C has a total construction cost of $16,937.00, a simple payback period of 3.87 years, and a SIR of 2.46.

Project D (Project A + B + C) falls under the category of a non MMCAR project as a OSD Productivity Investment Funding (OSD PIF) which is for projects that have a total construction cost of more than $100,000.00 and a simple payback period of four years or less. Project D has a total construction cost of $122,807.00, a simple payback period of 3.43 years, and a SIR of 2.78.

TABLE 9 - ENERGY CONSERVATION OPPORTUNITIES INCLUDED IN THE LOW-COST PROJECT

BUILDING	ECO NAME	SIR	PAYBACK (YRS)	CONSTRUCTION COST	ENERGY SAVINGS MBTU/YR ELEC	ENERGY SAVINGS MBTU/YR GAS	ANNUAL ENERGY($) SAVINGS
1520	Insulate DHW Tank	3.23	8.06	203	0.	6.25	26
	Reduce Light Level in Assembly	13.27	.98	50	3.	0.	53
	Shower Flow Limiters	116.26	.22	91	0.	100.8	420
	High Efficiency Motors	37.26	.35	187	31.51	0	556
1521	Delamp Lighting Fixtures in Rm B	16.34	.79	51	3.77	0.	66
	Shower Flow Limiters	77.22	0.34	137	0.	100.8	420
1610	Add Insulation to DHW Tank	2.72	9.58	442	0.	11.10	48
	Lower Domestic Hot Water Temperature	79.26	.33	25	0.	18.88	79
	Shower Flow Limiters	7.10	3.67	272	0.	18.4	79
	Install Weatherstrip on Front Doors	4.61	3.61	967	11.36	18.52	278
	High Efficiency Motors on Timeclock	1.36	9.52	120	0.74	0	13
Boswell	Occupancy Sensors	1.03	12.55	361	1.53	0.	30
	Add Insulation to DHW Tank	3.13	8.32	123	0.	3.67	15
	Delamp 20%	11.32	1.15	75	3.479	0.	68
	Shower Flow Restrictors	7.86	3.32	477	0.	35.7	149
	Hight Efficiency Motors	8.61	1.51	89	3.14	0	61

TABLE 9 - ENERGY CONSERVATION OPPORTUNITIES INCLUDED IN THE LOW-COST PROJECT

BUILDING	ECO NAME	SIR	PAYBACK (YRS)	CONSTRUCTION COST	ENERGY SAVINGS MBTU/YR ELEC	ENERGY SAVINGS MBTU/YR GAS	ANNUAL ENERGY($) SAVINGS
Callaghan	Add Insulation to DHW Heater	3.72	7.00	137	0.	4.86	20
	Shower Flow Restrictors	6.85	3.80	409	0.	26.7	111
	Replace Entryway Lights	1.40	9.29	565	3.62	0.	63
	High Efficiency Motors	2.69	1.69	89	3.14	0.	55
Old Spanish Trail	Insulate DHW Tank	3.08	8.47	142	0.	5.0	17
	Shower Flow Restrictors	15.65	1.66	149	0.	26.7	93
OST Annex B	Delamp Fixtures	6.30	2.06	240	7.667	0.	121
	Timeclock	157.83	0.08	30	24.0	0.	378
	Weatherstrip on Doors	1.34	19.48	1,367	0.	20.2	70
OST Annex C	Delamp in Office Area	26.93	.48	25	3.413	0.	54
Perimeter Park Whse	Shower Flow Restrictors	37.08	0.7	45	0.	9.3	66
	Delamp in Assembly Area	120.65	0.11	100	66.01	0.	962
	Insulate DHW Tank	4.59	5.68	63	0.	1.61	11
Fairview Drive	Hi-Efficiency Motors	33.71	.39	91	12.72	0.	224
	Shower Flow Restrictors	10.32	2.52	137	0.	10.40	56
	Timeclock for Chiller CHW & HW Pumps	1672.63	0.01	25	99.	132.	2,617
Fairview Drive AMSA	Shower Flow Restrictors	1.40	18.62	137	0.	1.41	8

TABLE 10 - ENERGY CONSERVATION OPPORTUNITIES INCLUDED IN PROJECT A

BUILDING	ECO NAME	SIR	PAYBACK (YRS)	CONSTRUC-TION COST	ENERGY SAVINGS MBTU/YR ELEC	ENERGY SAVINGS MBTU/YR GAS	ANNUAL ENERGY($) SAVINGS
1520	Replace Exit Signs	1.61	8.04	3,215	22.65	0.	399
	Install Photocell On Existing Lights	18.12	.72	134	10.98	0.	194
	Timeclock for Chiller CHW & HW Pumps W/High Eff. Motors	1.61	5.10	3,250	45.39	<39.18>	636
	Delamp Lighting Fixtures in Corridors	1.03	12.58	3,626	16.33	0.	288
	Delamp Lighting Fixtures in Rooms 111 and 136	3.10	4.19	1,812	24.5	0.	432
	Occupancy Sensors in Classrooms	2.14	6.06	5,033	47.	0.	830
	DHW Circulation Pump Control	1.86	6.99	81	.68	0.	12
	Reduce Light Level in Assembly	13.27	.98	50	3.	0.	53
1521	Occupancy Sensors Break Room	4.17	3.11	90	1.55	0.	27
	Occupancy Sensors Restrooms	1.27	10.26	180	1.03	0.	18
	Replace Exit Signs	1.56	8.31	419	2.96	0.	52
	Night Setback	3.55	4.20	9,207	15.	462	2,256

TABLE 10 - ENERGY CONSERVATION OPPORTUNITIES INCLUDED IN PROJECT A

BUILDING	ECO NAME	SIR	PAYBACK (YRS)	CONSTRUCTION COST	ENERGY SAVINGS MBTU/YR ELEC	ENERGY SAVINGS MBTU/YR GAS	ANNUAL ENERGY($) SAVINGS
1610	Photocells in Stairwells	1.65	7.88	409	3.047	0.	54
	Replace Boiler with Higher Efficiency Boiler on Timeclock	1.36	19.10	8,771	0.	110.	459
	Replace Exit Signs	1.34	9.68	2,098	12.28	0.	216
	Occupancy Sensors	2.96	4.38	180	2.41	0.	42
	Shutdown Energy to Water Heater	2.28	11.45	1,696	0.	35.5	148
	Variable Speed Pumping for Chilled Water Pump on Timeclock	1.06	12.26	2,444	11.30	0.	199
	Timeclock for Chiller, CHW and HW Pumps, with Interactive Effects	21.54	.60	914	42.	201.	1,588
1611	Replace Incandescent Light and Install Photocell	1.69	7.68	301	2.3	0.	41
	Infrared Heaters with Night Setback	2.13	6.65	3,345	7.	91.	503
Boswell	Occupancy Sensors	1.03	12.55	361	1.53	0.	30
	Replace Exit Signs	1.72	7.55	978	6.89	0.	134
	Night Setback	40.55	.5	2,495	109.	677.	5,025

TABLE 10 - ENERGY CONSERVATION OPPORTUNITIES INCLUDED IN PROJECT A

BUILDING	ECO NAME	SIR	PAYBACK (YRS)	CONSTRUCTION COST	ENERGY SAVINGS MBTU/YR ELEC	ENERGY SAVINGS MBTU/YR GAS	ANNUAL ENERGY($) SAVINGS
Callaghan	Replace Exit Sign	2.76	4.70	1,485	18.15	0.	316
	Night Setback w/High Efficiency Boiler	8.62	2.21	3,355	103.	375.	3,355
Callaghan Maintenance	Infrared Heaters and Night Setback	2.13	6.67	3,345	7.	91.	501
	Replace Incandescent Lights and Install Photocell	1.67	7.79	301	2.3	0.	40

TABLE 11 - ENERGY CONSERVATION OPPORTUNITIES INCLUDED IN PROJECT B

BUILDING	ECO NAME	SIR	PAYBACK (YRS)	CONSTRUCTION COST	ENERGY SAVINGS MBTU/YR		ANNUAL ENERGY($) SAVINGS
					ELEC	GAS	
Old Spanish Trail	Chiller Pre-coolers	1.12	8.68	14,081	102.97	0.	1,620
	Occupancy Sensors	1.01	12.91	361	1.84	0.	29
	Insulate HW Coil Headers	10.57	2.46	497	0.	60.15	209
	Timeclock for DHW Pump	8.16	1.59	81	3.35	0.	53
OST Annex B	Disable Air Conditioner	786.25	0.01	30	160.	0.	2,517
	Replace Boiler with Higher Efficiency Boiler	10.81	2.41	3,498	0.	418.0	1,450
Perimeter Park	Install Photocell	3.26	3.98	134	2.39	0.	34
	Occupancy Sensors	1.16	11.19	271	1.72	0.	25
	Night Setback	7.32	1.32	5,430	281.	0.	4,094
	Delamp and Install Reflectors	1.34	9.65	14,145	100.47	0.	1,464
Perimeter Park Whse	Replace Unit Heaters with Infrared Heaters with Night Setback	26.63	.96	7,747	24.34	438.	8,091

TABLE 12 - ENERGY CONSERVATION OPPORTUNITIES INCLUDED IN PROJECT C

BUILDING	ECO NAME	SIR	PAYBACK (YRS)	CONSTRUCTION COST	ENERGY SAVINGS MBTU/YR		ANNUAL ENERGY($) SAVINGS
					ELEC	GAS	
Fairview Drive	Occupancy Sensors	1.85	7.02	180	1.38	0.	27
	Replace Exit Signs	1.76	7.38	1,118	7.87	0.	151
	Timeclock for DHW Circulation Pump	4.44	2.92	163	3.02	0.	58
	Timeclock on CHW/HW Pump and High Efficiency Boiler and Motors	6.37	2.67	6,421	86.	138.	2399
Fairview Drive AMSA	Occupancy Sensors	1.85	7.02	180	1.38	0.	27
	Replace Unit Heater with Infrared Heaters and Night Setback	3.00	5.10	8,456	4.89	289.1	1,657
	Replace Exit Signs	1.70	7.62	419	2.96	0.	57

IX. CONCLUSION

In general, each of the buildings studied, utilizes their energy fairly efficiently. There is no obvious or blatant waste. There may be some additional measures than those studied and/or recommended in this report which could be implemented in order to accomplish a minimal increase in the energy consumption reduction. However, the implementation of such additional measures would compromise the comfort of the building's occupants which would be undesirable. The recommended measures for reducing the Reserve Center's energy consumption do so without compromising personnel comfort while resulting in a lowering of the total facility energy consumption by an aggregate 21.7%.